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Competency-based education 101

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Abstract

Competency-based education (CBE) is not new to higher education. For decades, colleges have been granting credit for content a student has previously mastered through prior learning assessments. But another approach to CBE, one in which students are granted credit as they master new academic content, is now being offered at an increasing number of public and private institutions. At least one factor driving this shift is employer's expectations that even entry-level employees can handle problem-solving tasks within their domain. This requires institutions to define competency models that align with job functions and requires educators to integrate knowledge, skills and attitudes (KSAs) into the learning experiences. Focus groups comprised of industry leaders can help institutions define competency models that align to jobs available for each degree level. Competency models that include indicating behaviors that define the characteristics of each level of proficiency aid in course design and assessment. Faculty can use the competency model as the starting point for course design but the integration of KSAs into holistic learning tasks is complex. As faculty seek to adjust to the demands of CBE, van Merrienboer's 4C-ID methodology provides a framework for the discovery of the authentic tasks performed by experts in real-world settings. The core components (Learning Task, Supportive Information, Procedural Information, and Part-Task Practice) also guide faculty to transition authentic tasks into learning experiences that facilitate student proficiency across a competency model.

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Keywords: Learning experiences; Competency-based education; Course design; Instructional design

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1. Introduction

As world economies, business models, and technologies evolve, every sector of society is facing difficult questions as we reflect on the transformation happening before our eyes. Higher education in particular is facing a number of disruptive reflections about the escalating costs of obtaining a degree, the return on investment of a degree, low degree completion rates, the quality of student learning, and the need for competent entry-level employees [1]. These concerns have driven a variety of responses including competency-based education (CBE).

CBE is not new to higher education. For decades, colleges have been granting credit for content a student has previously mastered through prior learning assessments (PLA). But another approach to CBE, one in which students are granted credit as they master new academic content, is now being offered at institutions such as Western Governors University, the University of Wisconsin, or Southern New Hampshire University and many others.

Of course, the creation of competency-based degree programs require the development of a competency model. But CBE also impacts the design of learning modules. Within CBE, the educational approach shifts from knowledge transfer to providing the student with the knowledge, skills, and attitudes (KSAs) that enable problem solving in a future job context [2, 3]. This shift at the level of learning significantly impacts the teaching-learning process and the content that will drive the learning experience.

1.1. The need for instructional design

The expectation that entry-level employees will be able to recognize and solve problems, requires that faculty design examples and assessments that simulate the contexts students will experience in their future career. Problems that define parameters in the context of examples such as two trains moving toward one another at differing rates of speed are no longer sufficient. Now, problems and examples used in courses must align with authentic tasks used in business, industry, and / or other sectors related to the field of study.

This type of teaching and learning is much more complex than knowledge transfer. A knowledge transfer approach to teaching focused on isolated knowledge and skills with the expectation that students would figure out the integration and application into new contexts through work experiences. Teachers must now design learning experiences that integrate knowledge and skills into an authentic task that competent professionals perform [3].

Many institutions provide staff instructional designers to assist faculty. However, two key factors limit the impact of staff instructional designers on a specific course or program: 1) a high faculty to instructional designer ratio limits the amount of time spent on each course or with each faculty and 2) faculty expectations that the instructional designer will build the course in the LMS rather than collaborate on learning problems.

A course design process that supports the analysis necessary for effective integration of knowledge and skills with authentic contexts and tasks will guide the instructor through identification and sequencing of authentic tasks; design of task support information; design of procedural information; and design of part-task practice [4].

2. Competency modeling

Whether a campus launches a fully CBE-based program or uses a more traditional contact hour approach for awarding credit hours, program graduates are expected to be able to recognize and solve problems within their discipline of study. This puts pressure on program and course design to ensure competency models are driven from a perspective of application.

In a 2015 analysis of higher education approaches to course design, TiER1 consultants identified a generally consistent approach to program or curriculum design across the programs of an Illinois college. New programs began with an idea or desire for a new degree offering, review of courses and syllabi from other colleges, and selection of courses to offer at this campus.

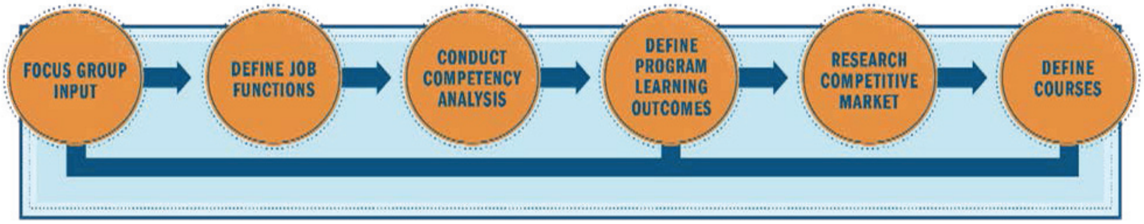

Fig. 1. Program curricula design process.

This process is an intuitive approach to program design, assuming others have done the hard work of analysis and leveraging personal experience as a guide to program design. More than a few significant details seem to be missing, including identification of instructional goals and instructional analysis [5]. When applied to curriculum design these components have significant implications, including research and analysis of workforce development needs including competencies and job functions of entry-level employees.

A more robust approach (Fig. 1) that includes representatives from industries most closely related to the new program will yield better insights. A focus group can provide the initial insights into the types of job opportunities and functions available to entry-level employees and provide feedback on program models. To increase the breadth and depth of input and feedback, the focus group should consist of representatives from employers and industry associations. With the input of this focus group and additional analysis of the industry, program designers will:

- Define the roles and job functions available for entry-level college graduates in their organizations.
- Establish the knowledge, skills, abilities, attitudes, and behaviors critical for success in those roles.
- Review industry standard competency models.

Deeper level of analysis can also be achieved by interviewing employees and their supervisors. This process will include functional analysis of the work performed, the types of problems encountered, and solution approaches.

Based on this research, program-level competencies can then be defined. Competency definitions typically include a description of the competency, a proficiency scale, and indicating behaviors that describe performance at each proficiency level. The indicating behaviors are keys to assessing proficiency performance in the same way that learning objectives are keys to measuring learning outcomes. As the competency model is defined, a final review from the focus group will be invaluable for making necessary modifications before courses are defined.

3. Instructional design

Once the competency model is finalized, courses need to be created. Using an instructional design model to guide the course develop process ensures learning objectives are met. The most common instructional design approach includes five phases: analysis, design, development, implementation and evaluation, known as ADDIE.

These phases describe the instructional designer's task to analyze the learning problem by investigating the business problem, training or education need, subject matter to be taught, and the audience background. In the design phase, the instructional designer not only authors the content but defines the learning interventions that will facilitate the attainment of the training goals across the required layers of Bloom's Taxonomy [6] (Fig. 2).

The first two phases (Analysis and Design) are critical to the success of the education program as they provide the foundation for the final three phases. In the Development and Implementation phases, content and learning interventions that will deliver the learning are created and deployed. Evaluation seeks to identify the success of the learning program and opportunities for improvement in the next iteration.

But good instructional design requires more than a five-phase process. The instructional designer must also know how to promote learning. M. David Merrill has identified five key principles (he called them the first principles of instruction) central to effective instructional design [7]. According to Merrill, learning is promoted when:

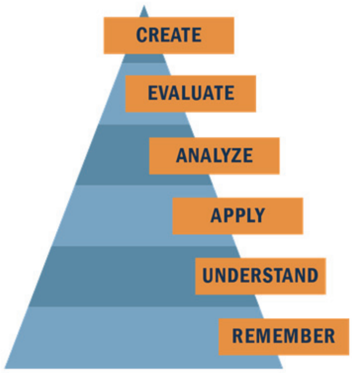

Fig. 2. Bloom's taxonomy.

1. Learners are engaged in performing real-life tasks or solving real-world problems;
2. Existing knowledge is activated as a foundation for new knowledge;
3. New knowledge is demonstrated to the learner;
4. New knowledge is applied by the learner; and
5. New knowledge is integrated into the learner's world.

These first principles of learning remind us that learning is more than knowledge transfer. In the context of CBE where instructors are seeking to provide a less compartmentalized learning experience, these first principles draw attention to the key factors that promote student success. Notice how Merrill defines learning engagement in terms of real-world tasks and problems. This definition removes the focus from engaging the hand that clicks an interaction on a screen to engaging the nervous system to solve problems.

When approaching the challenging work of effective integration of theory and practice with authentic contexts and tasks, good analysis and design are key to success. The Four Component Instructional Design (4C-ID) model seeks to provide a model that guides the analysis and design steps for better integration of knowledge, skills and abilities with real world problems and tasks [8].

3.1. Overview of 4C-ID

The 4C-ID model uses ten steps combined in four groups to ensure a thorough analysis (Table 1). One of the benefits of the model is that the ten steps are not linear steps to be worked through in a particular sequence but can be used in a zigzag approach based on the particular needs of the user and the course.

Table 1. 4C-ID model.

Four Components	Ten Steps
Learning Tasks	*1 Design Learning Tasks*
	2 Develop Assessment Instruments
	3 Sequence Learning Tasks
Supportive Information	*4 Design Supportive Information*
	5 Analyze Cognitive Strategies
	6 Analyze Mental Models
Procedural Information	*7 Design Procedural Information*

Four Components	Ten Steps
	8 Analyze Cognitive Rules
	9 Analyze Prerequisite Knowledge
Part-Task Practice	*10 Design Part-Task Practice*

Four of the ten steps are parallel to the four components while the remaining six steps support deeper analysis for the design work. The 4C-ID model uses the term *Learning Tasks* similarly to the term "authentic tasks" used previously, however the creators expand this to include other critical learning elements such as small group projects and use cases that must be studied. Additionally, van Merrienboer and Kirschner identify categories of tasks including non-routine skills and routine skills. Non-routine skills are critical learning experiences that are often not described in typical course learning objectives such as critical thinking or problem solving [4]. While working toward mastery of these skills, learners will need to lean on *Supportive Information*. Routine skills are behaviors or processes that are used in the learning task. While mastering these skills, learners will need to lean on *Procedural Information*. Some of these routine skills will need to be learned so well that they become automatic when applied to a given situation. These skills will require *Procedural Information* and *Part-Task Practice* that will help students develop the automaticity needed for success.

When learning to ride a motorcycle, skills such as negotiating curves and negotiating obstacles may be examples routine skills. But it will be critical for the student rider to develop automaticity for both of these skills (Fig. 3). A good motorcycle course will provide a lot of part-task practice for these skills.

The lower portion of the diagram below (Fig. 4.) shows the primary components of the 4C-ID model (Steps 1, 4, 7 and 10). This schematic will clarify how these pieces work together in the design of instruction.

The large circles represent the design of learning tasks, grouped into task classes. Each task class contains learning task that share the same complexity and provide a whole, concrete learning experience. In the diagram, each learning task is shown with a triangle pointer and varying levels of fill. These characteristics of the schematic represent variability in the task (triangle) and variability in depth of support and guidance provided (fill). So that each task is varied similarly to a real-world problem, while the student is provided less support and guidance over time [4]. Each task class is supported with procedural information (arrows pointing up to the circles) and supportive information (L-shaped brackets). Part-task practice is represented by the smaller circles, this is where students experience focused exercises to develop automaticity for critical tasks.

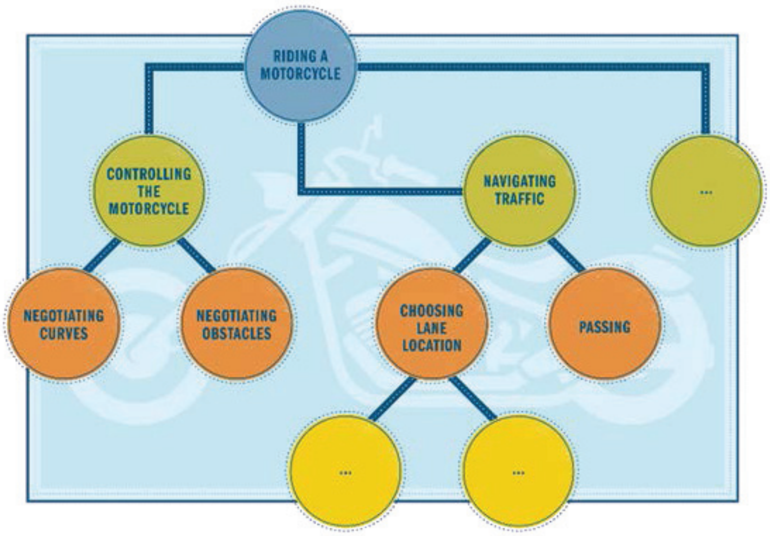

Fig. 3. Skills hierarchy for riding a motorcycle.

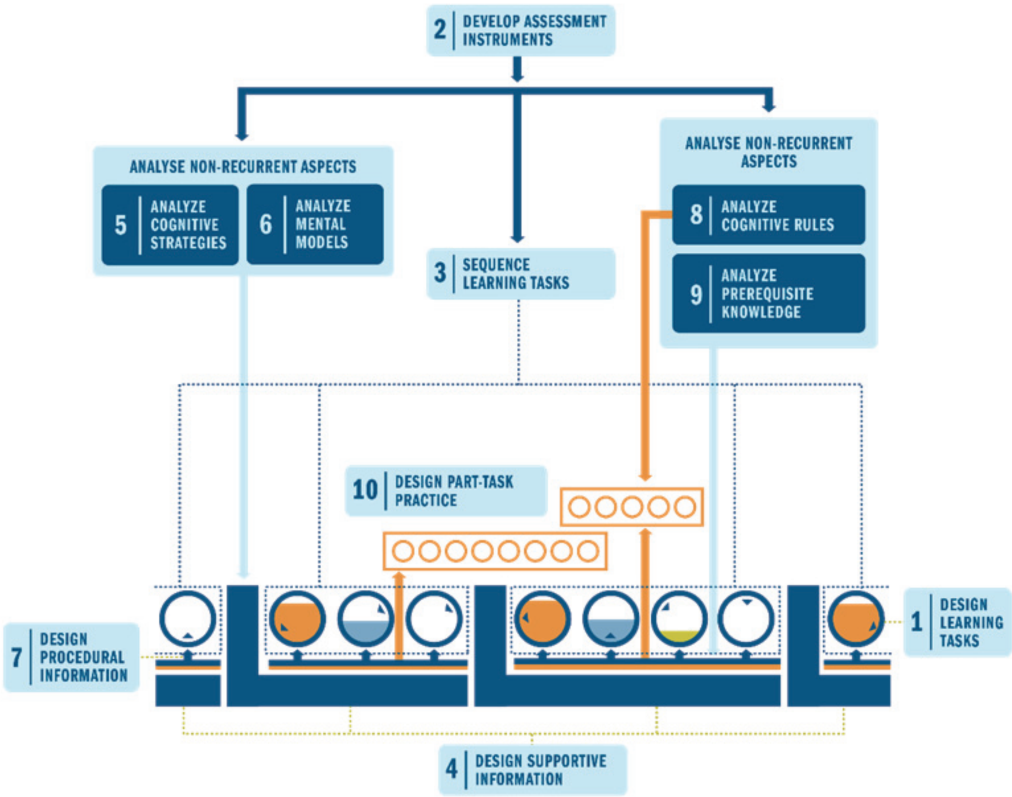

Fig. 4. 4C-ID model [4].

3.2. 4C-ID supporting tasks

The Learning Tasks component includes two supporting steps: developing assessment instruments; and sequencing learning tasks. The integration of knowledge, skills and attitudes in CBE requires the development of assessment instruments that measure performance across the learning task. Assessments should include the action, conditions and the standards (criteria, values and attitudes) for successful performance [4]. The sequencing step includes the simplification of learning tasks so that students experience the whole task in a simplified model while encountering gradually more complex iterations that will increase their proficiency.

The Supporting Information component also includes two supporting steps: analyze cognitive strategies; and analyze mental models. In the 4C-ID diagram (Fig. 4.) these two steps are shown side-by-side because they are independent, one is not conditional to another. "The analysis of cognitive strategies answers the question: How do proficient task performers systematically approach problems in the task domain? The analysis of mental models answers the question: How is the domain organized?" [4]. Each of these tasks seeks to uncover supporting content that will promote learning of the KSAs for the task. Supporting information may also include feedback that will help guide or remediate the learner. Feedback and remediation are critical for student success and improving student retention rates.

The Procedural Information component also includes two supporting steps: analyze cognitive rules; and analyze prerequisite knowledge. Analysis of the cognitive rules seeks to identify the *If … Then* rules and procedures that describe how a task is performed successfully [4]. This step is helpful in determining the prerequisite knowledge needed for the task. In the 4C-ID diagram (Fig. 4), steps 8 and 9 are arranged with one over the other because, unlike steps 5 and 6, these tasks are not independent. Analysis of cognitive rules is the first step in identifying the procedures of the task. The prerequisite knowledge may include concepts, facts, guiding principles, physical models, etc.

3.3. 4C-ID example

When learning to ride a motorcycle, negotiating obstacles is one of the key competencies and is a required skill for obtaining a license. The assessment (step 2) for this is to weave the motorcycle through a series of cones arranged in 2 columns, each with six cones. The columns are spaced four feet apart and there is 20 feet between each cone. This assessment is completed in a large open space like a parking lot, without many of the risks (i.e. traffic, obstacles in motion, ice and snow) a rider will encounter in the real world. But this assessment is the minimum proficiency for this competency needed to obtain a license.

Considering the 4C-ID Model in the context of learning to ride a motorcycle, we know the top level learning task is riding a motorcycle and the second level learning task for this example is negotiating obstacles by swerving. Other constituent tasks may be:

- Assessing the situation
- Swerving to miss the obstacle
- Maintaining balance through the swerve
- Connecting multiple swerves
- Slowing down
- Shifting gears
- Being visible to other drivers
- Understanding and using controls
- Using front and rear brakes
- Proper posture

By breaking this learning task into task classes that increase in complexity, the learning experience may be partially defined this way:

Table 2. Example task classes.

Task Class	*Ride the motorcycle up to a cone and stop*
Learning Tasks	Proper posture; understanding and using controls; using front and rear brakes
Supportive Information	Safety equipment; correct posture; feel engaged and in control; controls diagram; assessing the situation
Procedural Information	How to use front and rear brakes together
Task Class	*Ride motorcycle around a track with two curves.*
Learning Tasks	Previous task plus leaning to turn; slowing down; negotiating curves
Supportive Information	Previous task plus function of the clutch; gear pattern
Procedural Information	Previous task plus changing gears, best practices for entering and exiting curves
Task Class	*Swerve motorcycle through set of 12 cones 20 feet apart, turn and repeat*
Learning Tasks	Previous task plus swerving; maintaining balance; negotiating sharp turns
Supportive Information	Previous task plus centre of gravity
Procedural Information	Previous task plus best practices for swerving in various conditions; connecting multiple swerves

In this example, the task classes increase in complexity but each contains and an authentic task that the rider will need to learn. As each task increases in complexity, new supportive information is provided. As novice riders continue to practice these skills, support and procedural information will be removed and they will need to operate the motorcycle without learning on those materials.

4. Conclusion

Competency-based education is changing how students earn college credit and how faculty provide instruction. Administration, students, and employers expect education to prepare men and women for decision making and application of their knowledge in a variety of domain problems. CBE requires a well-defined competency model that leverages input from industry sources and well-designed courses based on authentic tasks.

Research has shown [3,4,9] that CBE is improved when knowledge, skills, attitudes are integrated into the learning experience rather than delivered in compartmentalized instruction. However, this integration is very complex, requiring more attention to analysis and design than traditional knowledge transfer. The 4C-ID approach was specifically created for CBE in which students earn credit as they master new academic content [3].

As faculty seek to adjust to the demands of CBE, the 4C-ID methodology provides a framework for the discovery of the authentic tasks performed by experts in real-world settings. The core components (Learning Task, Supportive Information, Procedural Information, and Part-Task Practice) also guide faculty to transition authentic tasks into learning experiences that will facilitate student proficiency across a competency model.

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